

223-37

(3)

(19)



Europäisches Patentamt

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Office européen des brevets



(11)

EP 0 560 936 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

27.03.1996 Bulletin 1996/13

(51) Int Cl.⁶: H01J 61/34(86) International application number:
PCT/US91/08860

(21) Application number: 92902999.9

(87) International publication number:
WO 92/10848 (25.06.1992 Gazette 1992/14)

(22) Date of filing: 25.11.1991

(54) REFLECTOR LAMP ASSEMBLY INCLUDING METAL HALIDE ARC TUBE

REFLEKTORLAMPENANORDNUNG MIT METALLHALOGENID-BOGENROHR

ENSEMBLE LAMPE A REFLECTEUR COMPORTANT UN TUBE A ARC A HALOGENE-METAL

(84) Designated Contracting States:
BE DE FR GB NL◦ WHITE, Robert, S.
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(30) Priority: 06.12.1990 US 623312

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London, WC2B 6UZ (GB)(43) Date of publication of application:
22.09.1993 Bulletin 1993/38(73) Proprietor: FLOWIL INTERNATIONAL LIGHTING
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NL-1077 ZX Amsterdam (NL) 307-03(56) References cited:
EP-A- 0 104 594 EP-A- 0 306 269
EP-A- 0 363 991 FR-A- 1 118 185
FR-A- 1 242 662 GB-A- 828 020
US-A- 3 250 934(72) Inventors:
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EP 0 560 936 B1

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Description

This invention relates to electric lamps for general illumination and, more particularly, to electric lamps utilizing a metal halide arc tube mounted in a sealed reflector.

Lamp assemblies incorporating reflectors are well known. Examples include spotlights and floodlights for indoor and outdoor use. A lamp is mounted in a sealed outer envelope which includes a reflecting interior surface, typically parabolic, for directing light in a preferred direction. The reflector is covered with a lens, and a base is provided for mounting the lamp assembly and for interconnection of the lamp assembly to an electrical energy source. Incandescent lamps, highpressure sodium arc tubes and mercury arc tubes have been utilized in such lamp assemblies.

Recently, it has been proposed to utilize metal halide arc tubes in reflector lamp assemblies. Metal halide arc tubes provide excellent colour, long life and high efficiency. Low wattage halide arc tube assemblies include an arc tube which encloses a suitable fill material such as sodium, scandium and mercury iodides. Electrodes are located within the arc tube at opposite ends, and electrode leads extend through press seals for connection to an electrical source. An example of a reflector lamp assembly utilizing a metal halide arc tube is disclosed in EP-A-0,363,991.

It has been found desirable to mount metal halide arc tubes within a light-transmissive quartz shroud or shield. The shroud produces a higher and more uniform arc tube temperature than would otherwise occur. The shroud is, in part, responsible for the excellent colour temperature and the long operating life of metal halide arc lamps. In addition, it is known that metal halide arc tubes are subject to burst on rare occasions. The shroud contains shards of the arc tube when the burst occurs.

When a metal halide arc tube is mounted in a reflector, several requirements must be met. It is preferred, in order to maximize light output, that the axis of the arc tube be aligned with the optical axis of the reflector and that the center of light output of the arc tube coincide with the focal point of the reflector. The mounting arrangement for the arc tube must provide means for mounting both the shroud and the arc tube. The arc tube and the shroud must be securely mounted within the lamp envelope to prevent damage during shipping and handling.

In conventional arc discharge lamps which utilize a bulbous lamp envelope, the arc tube and shroud are mechanically supported from both ends of the lamp envelope. However, the process of fabricating a reflector lamp assembly involves heating steps which cause the reflector to sag under the weight of the lens. Later in the process, a pressurized gas is introduced into the lamp envelope in order to raise the lens to a desired height. This variation in dimensions during processing precludes the mount assembly for the arc tube and shroud from being secured to the lens.

It is well known that conductors located in proximity to an arc discharge tube containing sodium cause sodium migration, or sodium electrolysis. Sodium ions migrate through the wall of the arc tube and thereby reduce the life of the lamp. It has been found desirable to keep conducting frame members and power leads away from the arc tube to the extent possible. In prior lamp assemblies which do not include a reflector, a frameless construction has been utilized in which a fine wire connects the arc tube electrode at the dome end of the lamp to the electrical feedthrough at the base end of the lamp. The arc tube is maintained in position by bulb spacers at the base and dome ends of the lamp envelope. The electrically-isolated floating frame develops a positive charge which inhibits the migration of sodium ions through the arc tube. As noted above, a double-ended mechanical mount is not feasible in a reflector lamp assembly.

It is known from EP-A-0363991 to provide an electric lamp comprising:

a lamp envelope having a base region including a base for connection to an electrical source;
an arc tube having an upper electrode lead and a lower electrode lead extending from opposite ends thereof; a light-transmissive shroud disposed around said arc tube.

The present invention is characterised in that said shroud has a cylindrical, open-ended configuration;

first and second clips are attached to opposite ends of said arc tube, each of said clips including a portion for retaining said shroud;

a connection member being attached to said first and second clips such that said shroud is retained between said first and second clips in a fixed position relative to said arc tube, said connection member being unattached to said lamp envelope; and support means being provided for mechanically supporting said arc tube in said lamp envelope entirely from the base region of said lamp envelope and for coupling electrical energy to said arc tube.

The lamp preferably includes a support ring attached to the connection member for limiting radial movement of the arc tube and the shroud relative to the lamp envelope when the lamp is subjected to mechanical shock. In a preferred embodiment, the connection member comprises a connection rod having a first section located outside the shroud between the first and second clips and a second section extending between the first section and the support ring.

The support ring preferably has an outside diameter that is slightly less than the inside diameter of the lamp envelope adjacent to the support ring.

In a preferred embodiment, the first and second clips each include a strap having inturned ends. An arcuate portion is affixed to one of the inturned ends, and a tab

is affixed to the other of the inturned ends. The arcuate portion encircles a portion of the shroud, and the tab is attached to the connection member. The first and second clips each further include projections for retaining the arc tube.

The support means preferably comprises an upper electrode support coupled to the upper electrode lead of the arc tube and extending outside the shroud to the base, and a lower electrode support coupled to the lower electrode lead of the arc tube and extending to the base. The upper and lower electrode supports provide mechanical support of the arc tube in the lamp envelope and carry electrical energy to the arc tube.

Some preferred embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

FIG. 1 is an elevational view, partly in cross-section, of a preferred reflector lamp in accordance with the present invention;

FIG. 2 is a perspective view showing the arc tube assembly of the lamp shown in FIG. 1; and

FIG. 3 is an exploded view showing the arc tube, shroud, clips and connection member of the lamp shown in FIG. 1.

A preferred electric lamp in accordance with the present invention is shown in FIG. 1. Detailed views of the arc tube assembly are shown in Figs. 2 and 3. A lamp envelope 10 provides a sealed enclosure for an arc tube assembly 12. The lamp envelope 10 includes a reflector 14 having circular symmetry about an optical axis 16. A reflecting surface 18 on the interior surface of reflector 14 typically has a parabolic shape. The reflecting surface 18 can be an aluminum coating, a dichroic reflector or any other suitable reflector. Reflector 14 is closed by a lens 20. A base 22 provides a means for supplying electrical energy to the arc tube assembly 12 and for mounting of the lamp. Typically, the lamp envelope 10 is filled with nitrogen at a pressure of approximately 5.32×10^4 Pa (400 torr). An electric lamp of the type shown in FIG. 1 is typically utilized as a downlight, a spotlight, or a floodlight for indoor or outdoor illumination.

The arc tube assembly 12 includes an arc tube 30. The arc tube 30 is typically a low-wattage metal halide lamp such as a type M100 manufactured and sold by GTE Products Corporation. Arc tube 30 encloses a discharge region 32 containing a fill material such as sodium, scandium and mercury iodides, and argon at a pressure of 1.33×10^4 Pa (100 torr). Electrodes 31 and 33 are located at opposite ends of the arc tube 30 and are coupled to external electrode leads 34 and 36 through press seals 38 and 40, respectively.

The arc tube 30 is mounted in lamp envelope 10 with its longitudinal axis on the optical axis 16 of reflector 14. Preferably, a light center 42 of arc tube 30 is positioned at the focal point of reflecting surface 18 for maximum light output in the desired direction.

The arc tube 30 is positioned within a light-transmissive shroud 48. The shroud 48 is typically fabricated of quartz and comprises a right circular cylinder that is open at both ends. Shroud 48 provides a higher and more uniform temperature during operation of arc tube 30 than would otherwise occur without the shroud. The shroud 48 is, in part, responsible for the excellent colour temperature and the long operating life of metal halide arc tubes. In addition, the shroud 48 provides a containment function in the rare event of an arc tube burst. The shroud 48 absorbs energy from shards of the arc tube 30. Although the shroud 48 may be shattered by a burst arc tube, the energy of the burst is partially absorbed so that the shards are completely contained within the lamp envelope 10. Shroud 48 preferably has a wall thickness of approximately one to three millimetres.

The mounting structure for the arc tube 30 and the shroud 48 includes an upper electrode support 50 attached to electrode lead 34 and a lower electrode support 52 attached to electrode lead 36. The electrode supports 50 and 52 mechanically support the arc tube 30 within lamp envelope 10 and carry electrical energy to arc tube 30. Upper electrode support 50 extends transversely from electrode lead 34 and then extends downwardly outside shroud 48 to the base region of the lamp. Preferably, a section 50a of electrode support 50 is spaced as far as is practical from the outside surface of shroud 48 in order to minimize sodium migration which can be caused by the presence of a conducting surface in proximity to arc tube 30. Lower electrode support 52 extends transversely from electrode lead 36 and then downwardly to the base region of the lamp. The downwardly-extending portions of the electrode supports 50 and 52 are preferably located on opposite sides of the base region of the lamp envelope 10 and are welded to electrode leads 34 and 36, respectively.

The mounting structure for arc tube 30 and shroud 48 further includes an upper clip 60 and a lower clip 62 which secure arc tube 30 and shroud 48 to a connection rod 64. A support ring 66 is located in a heel region 68 of the lamp envelope 10 and is attached to connection rod 64. The connection rod 64 includes a first section 70 located outside shroud 48 and attached between upper clip 60 and lower clip 52. The connection rod 64 further includes a second section 72 that extends between lower clip 62 and support ring 66. The first section 70 is generally parallel to optical axis 16, and second section 72 is offset in a generally radial direction.

Each of the clips 60 and 62 is preferably formed as an integral metal element including a strap 80 having inturned ends 82 and 84. An arcuate portion 86 is affixed to inturned end 82, and a tab 88 is affixed to inturned end 84. The arcuate portion 86 encircles a portion of the circumference of shroud 48. The strap 80 passes over and bears against the end of shroud 48. The spacing between inturned ends 82 and 84 is the same or slightly larger than the outside diameter of shroud 48 so that shroud 48 is retained between inturned end 84 and ar-

cuate portion 86. Tab 88 is preferably welded to connection member 64. The strap 80 is provided with spaced apart projections 90 and 92 for retaining arc tube 30 between them. In a preferred embodiment, the projections 90 and 92 are generally U-shaped portions which are perpendicular to strap 80. The projections 90 and 92 are spaced to receive the press seal 38 of arc tube 30. The strap 80 includes an opening 94 of sufficient size to provide clearance for electrode lead 34. Clips of the type shown in FIG. 3 are disclosed in US-A-5252885 and US-A-5136204.

In one example, the connection rod 64 is nickelplated steel having a diameter of 1.27mm (0.050-inch). The support ring 66 can be fabricated from any relatively rigid material. In one example, a strip of nickel 3.17mm (0.125-inch) wide and 0.25mm (0.010-inch) thick was used to form the support ring 66. The support ring 66 is positioned in the heel region 68 of the lamp envelope 10. Preferably, the outside diameter of support ring 66 is slightly less than the inside diameter of heel region 68. With this arrangement, the lamp can be assembled using automatic assembly equipment. When the lamp is subjected to mechanical shock during shipping and handling, the support ring 66 comes into contact with heel region 68 and cushions the arc tube assembly 12. The support ring 66 prevents the arc tube assembly 12 from being damaged or dislocated from its normal position in lamp envelope 12. In a preferred embodiment of the support ring 66, a strip of nickel 3.17mm (0.125-inch) wide and 0.25mm (0.010-inch) thick is used to form a two-layer support ring. Where the two layers overlap, the support ring includes three layers. At the overlap region, the support ring 66 is welded to the offset portion 72 of the connection rod 64.

The upper clip 60, lower clip 62, connection rod 64 and support ring 66 are mechanically and electrically isolated from upper electrode support 50 and lower electrode support 52. The upper and lower electrode supports 50 and 52 are attached to the base of the lamp as described in the aforementioned patent EP-A-0363991.

Thus, at least in preferred embodiments, there is provided an improved reflector lamp assembly which utilizes a metal halide arc discharge tube with minimal sodium migration; which has a long operating life; is suitable for mounting in a reflector; wherein all conductive parts except the electrical inleads are electrically isolated; furthermore, which provides a metal halide reflector lamp assembly that is compatible with automatic assembly equipment; that is capable of withstanding mechanical shock and vibration during routine shipping and handling; and that is easily manufactured and low in cost.

Claims

1. An electric lamp comprising:

a lamp envelope (10) having a base region

including a base (22) for connection to an electrical source;

an arc tube (30) having an upper electrode lead (34) and a lower electrode lead (36) extending from opposite ends thereof; a light-transmissive shroud (48) disposed around said arc tube (30), characterised in that said shroud (48) has a cylindrical, open-ended configuration;

first and second clips (60,62) are attached to opposite ends of said arc tube (30), each of said clips (60,62) including a portion (80,86) for retaining said shroud (48);

a connection member (64) being attached to said first and second clips (60,62) such that said shroud (48) is retained between said first and second clips (60,62) in a fixed position relative to said arc tube (30), said connection member (64) being unattached to said lamp envelope (10); and

support means (50,52) being provided for mechanically supporting said arc tube (30) in said lamp envelope (10) entirely from the base region of said lamp envelope (10) and for coupling electrical energy to said arc tube (30).

2. An electric lamp as claimed in claim 1, further including a support ring (66) attached to said connection member (64).

3. An electric lamp as claimed in claim 2, wherein said support ring (66) has an outside diameter that is slightly less than the inside diameter of said lamp envelope (10) adjacent to said support ring (66).

4. An electric lamp as claimed in claim 2 or 3, wherein said support ring (66) is positioned between a lower end of said shroud (48) and said base region.

5. An electric lamp as claimed in any preceding claim, wherein said connection member comprises a connection rod (64) located outside said shroud (48) between said first and second clips (60,62).

6. An electric lamp as claimed in claim 5, wherein said connection rod (64) has a first section (70) located outside said shroud (48) between said first and second clips (60,62) and a second section (72) extending between said first section (70) and said support ring (64).

7. An electric lamp as claimed in any preceding claim, wherein said first and second clips (60,62) each include a strap (80) having inturned ends (82,84), an arcuate portion (86) affixed to one of said inturned ends (82) and a tab (88) affixed to the other of said inturned ends (84), said arcuate portion (86) encircling a portion of the shroud (48), said tab (88) being attached to said connection member (64), said first

and second clips (60,62) each further including spaced-apart projections (90,92) for retaining said arc tube (30).

8. An electric lamp as claimed in any preceding claim, wherein said support means (50,52) comprises:

an upper electrode support (50) coupled to the upper electrode lead (34) of said arc tube (30) and extending outside said shroud (48) to said base (22); and
a lower electrode support (52) coupled to the lower electrode lead (36) of said arc tube (30) and extending to said base (22), said upper and lower electrode supports (50,52) providing mechanical support of said arc tube (30) in said lamp envelope (10) and coupling electrical energy to said arc tube (30).

9. An electric lamp as claimed in claim 8, wherein said upper electrode support (50) is spaced from an outer surface of said shroud (48).
10. An electric lamp as claimed in any preceding claim, wherein said arc tube comprises a metal halide arc tube (30) having press seal regions (38,40) at opposite ends thereof.
11. An electric lamp as claimed in any preceding claim, wherein said lamp envelope (10) includes a reflecting interior surface (18) for redirecting light from said arc tube (30) and a lens (20) enclosing one end thereof.

Patentansprüche

1. Elektrische Lampe aus

einer Lampenhülle (10) mit einem Sockelbereich, der einen Sockel (22) zur Verbindung mit einer Stromquelle aufweist;

einer Entladungsröhre (30) mit einer oberen Elektrodenzuleitung (34) und einer unteren Elektrodenzuleitung (36), die sich von einander gegenüberliegenden Enden derselben weg erstrecken; und einer rund um die Entladungsröhre (30) angeordneten, lichtdurchlässigen Abschirmung (48),

dadurch gekennzeichnet, daß Abschirmung (48) eine zylindrische, offenendige Gestalt aufweist;

daß an den einander gegenüberliegenden Enden der Entladungsröhre (30) erste und zweite Clips (60, 62) befestigt sind, von denen jeder Clip (60, 62) einen Abschnitt (80, 66) für die Halterung der Abschirmung (48) besitzt; daß ein Verbindungselement (64) am ersten

und zweiten Clip (60, 62) derart befestigt ist, daß die Abschirmung (48) in einer fixierten Stellung relativ zur Entladungsröhre (30) zwischen dem ersten und dem zweiten Clip (60, 62) gehalten ist, wobei das Verbindungselement (64) nicht mit der Lampenhülle (10) verbunden ist; und

daß Stützelemente (50, 52) zur mechanischen Halterung der Entladungsröhre (30) innerhalb der Lampenhülle (10) ausschließlich vom Sockelbereich der Lampenhülle (10) und für den Anschluß elektrischer Leistung an die Entladungsröhre (30) vorgesehen sind.

2. Elektrische Lampe nach Anspruch 1, die einen mit dem Verbindungselement (64) verbundenen Stützring (66) aufweist.

3. Elektrische Lampe nach Anspruch 2, bei welcher der Stützring (66) einen Außendurchmesser besitzt, der etwas geringer ist als der dem Stützring (66) benachbarte Innendurchmesser der Lampenhülle (10).

4. Elektrische Lampe nach Anspruch 2 oder 3, bei welcher der Stützring (66) zwischen einem unteren Ende der Abschirmung (48) und dem Sockelbereich angeordnet ist.

5. Elektrische Lampe nach einem der vorhergehenden Ansprüche, bei welcher das Verbindungselement einen außerhalb der Abschirmung (48) zwischen dem ersten und dem zweiten Clip (60, 62) angeordneten Verbindungssteg (64) aufweist.

6. Elektrische Lampe nach Anspruch 5, bei welcher der Verbindungssteg (64) einen außerhalb der Abschirmung (48) zwischen dem ersten und dem zweiten Clip (60, 62) angeordneten ersten Abschnitt (70) und einen sich zwischen dem ersten Abschnitt (70) und dem Stützring (64) erstreckenden zweiten Abschnitt (72) aufweist.

7. Elektrische Lampe nach einem der vorhergehenden Ansprüche, bei welcher der erste und der zweite Clip (60, 62) jeweils einen Bügel (80) mit einwärts gebogenen Enden (82, 84) aufweisen, einen bogenförmigen Bereich (86), der an einem der einwärts gebogenen Enden (82) befestigt ist, und einen an dem anderen der einwärts gebogenen Enden (84) befestigten Steg (88), wobei der bogenförmige Bereich (86) einen Teil der Abschirmung (48) umgibt, der Steg (88) am Verbindungselement (64) befestigt ist, und der erste und der zweite Clip (60, 62) jeweils zusätzlich voneinander im Abstand angeordnete Vorsprünge (90, 92) für die Halterung der Entladungsröhre (30) aufweisen.

8. Elektrische Lampe nach einem der vorhergehenden Ansprüche, bei welcher die Stützelemente (50, 52) umfassen:

eine obere Elektrodenhalterung (50), die mit der oberen Elektrodenzuleitung (34) der Entladungsröhre (30) verbunden ist und sich auf der Außenseite der Abschirmung (40) zum Sockel (22) hin erstreckt; und
eine untere Elektrodenhalterung (52), die mit der unteren Elektrodenzuleitung (36) der Entladungsröhre (30) verbunden ist und sich zum Sockel (22) hin erstreckt, wobei die oberen und unteren Elektrodenhalterungen (50, 52) eine mechanische Halterung der Entladungsröhre (30) in der Lampenhülle (10) sowie einen Anschluß elektrischer Leistung an die Entladungsröhre (30) gewährleisten.

9. Elektrische Lampe nach Anspruch 8, bei welcher die obere Elektrodenhalterung (50) von einer äußeren Fläche der Abschirmung (48) in Abstand angeordnet ist.

10. Elektrische Lampe nach einem der vorhergehenden Ansprüche, bei welcher die Entladungsröhre aus einer Metallhalogenid-Entladungsröhre (30) mit Quetschdichtungen (30, 40) an ihren einander gegenüberliegenden Enden besteht.

11. Elektrische Lampe nach einem der vorhergehenden Ansprüche, bei welcher die Lampenhülle (10) eine reflektierende Innenfläche (18) für das Zurückwerfen von Licht der Entladungsröhre (30) und eine ihr eines Ende abschließende Linse (20) aufweist.

Revendications

1. Lampe électrique comprenant :

une ampoule de lampe (10) ayant une région de culot incluant un culot (22) pour une connexion à une source électrique ;

un tube à arc (30) ayant un conducteur (34) d'électrode supérieure et un conducteur (36) d'électrode inférieure, faisant saillie des extrémités opposées du tube à arc ; un bouclier (48) transmettant la lumière disposé autour du dit tube à arc (30) ;

caractérisée en ce que

le dit bouclier (48) affecte une forme cylindrique à extrémités ouvertes ;

des premier et deuxième étriers (60, 62) sont fixés aux extrémités opposées du dit tube à arc (30), chacun des dits étriers (60, 62) comportant une partie (80, 86) pour maintenir le dit bouclier (48) ;

un élément de connexion (64) étant fixé aux dits premier et deuxième étriers (60, 62) de telle manière que le dit bouclier (48) soit maintenu entre les dits premier et deuxième étriers (60, 62) en une position fixe par rapport au dit tube à arc (30), le dit élément de connexion (64) n'étant pas attaché à la dite ampoule (10) de la lampe ; et

un moyen formant support (50, 52) étant prévu pour porter mécaniquement le dit tube à arc (30) dans la dite ampoule (10) de lampe entièrement à partir de la région du culot de la dite ampoule (10) de lampe et pour appliquer l'énergie électrique au dit tube à arc (30).

2. Lampe électrique selon la revendication 1, incluant, en outre, un anneau de support (66) fixé au dit élément de connexion (64).

3. Lampe électrique selon la revendication 2, dans laquelle le dit anneau de support (66) présente un diamètre externe qui est légèrement inférieur au diamètre interne de la dite ampoule (10) de lampe adjacente au dit anneau de support (66).

4. Lampe électrique selon la revendication 2 ou 3, dans laquelle le dit anneau de support (66) est positionné entre une extrémité basse du dit bouclier (48) et la dite région de culot.

5. Lampe électrique selon l'une quelconque des revendications précédentes, dans laquelle le dit élément de connexion comprend une barre (64) de connexion disposée à l'extérieur du dit bouclier (48) entre les dits premier et deuxième étriers (60, 62).

6. Lampe électrique selon la revendication 5, dans laquelle la dite barre de connexion (64) a une première partie (70) disposée à l'extérieur du dit bouclier (48) entre les dits premier et deuxième étriers (60, 62) et une deuxième partie (72) s'étendant entre la dite première partie (70) et le dit anneau de support (64).

7. Lampe électrique selon l'une quelconque des revendications précédentes, dans laquelle les dits premier et deuxième étriers (60, 62) incluent chacun une patte (80) ayant des extrémités repliées (82, 84), une partie arquée (86) fixée à l'une des dites extrémités repliées (82) et une languette (88) fixée à l'autre des dites extrémités repliées (84), la dite partie arquée (86) encerclant une partie du bouclier (48), la dite languette (88) étant fixée au dit deuxième élément de connexion (64), les dits premier et deuxième étriers (60, 62) incluant chacun, en outre, des projections séparées (90, 92) pour maintenir le dit tube à arc (30).

8. Lampe électrique selon l'une quelconque des revendications précédentes, dans laquelle le dit moyen de support (50, 52) comprend :

un support (50) de l'électrode supérieure relié 5
au conducteur (34) de l'électrode supérieure du
dit tube à arc (30) et faisant saillie hors du dit
bouclier (48) jusqu'au dit culot (22) ; et
un support (52) de l'électrode inférieure relié au 10
conducteur (36) de l'électrode inférieure du dit
tube à arc (30) et s'étendant jusqu'au dit culot
(22), les dits supports (50, 52) d'électrodes
supérieure et inférieure déterminant un support
mécanique du dit tube à arc (30) dans la dite 15
ampoule (10) de lampe et appliquant l'énergie
électrique au dit tube à arc (30).

9. Lampe électrique selon la revendication 8, dans 20
laquelle le dit support (50) d'électrode supérieure est
séparé d'une paroi externe du dit bouclier (48).
10. Lampe électrique selon l'une quelconque des reven-
dications précédentes, dans laquelle le dit tube à arc
comprend un tube à arc à halogénures métalliques 25
(30) présentant des régions de scellement par pin-
cement (38, 40) à ses extrémités opposées.
11. Lampe électrique selon l'une quelconque des reven-
dications précédentes, dans laquelle la dite 30
ampoule (10) de lampe inclut une paroi interne réflé-
chissante (18) pour re-diriger la lumière issue du dit
tube à arc (30) et une lentille (20) enfermant une des
extrémités de celui-ci.

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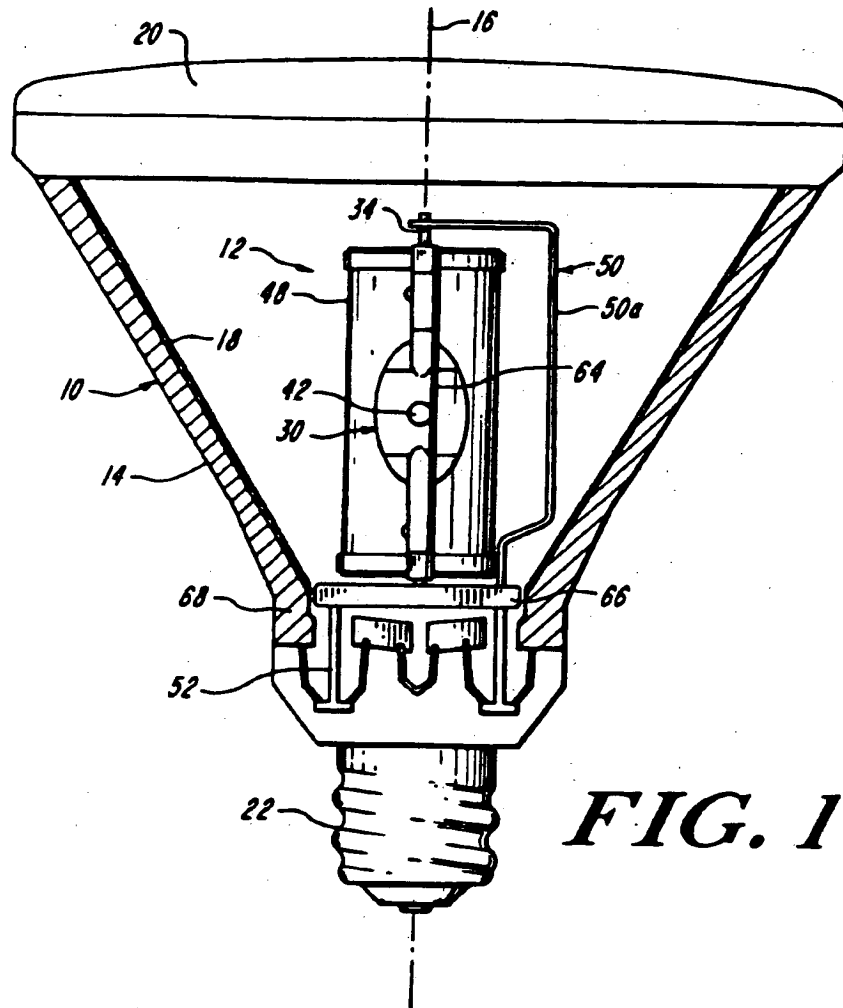


FIG. 1

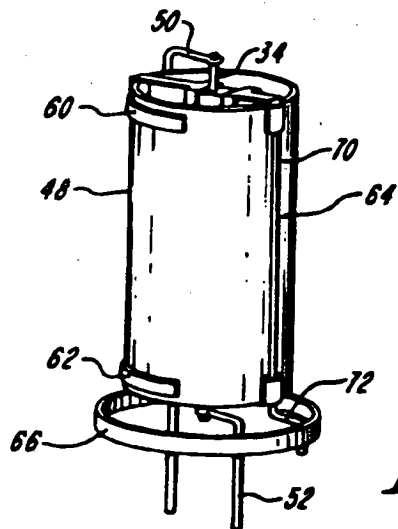


FIG. 2

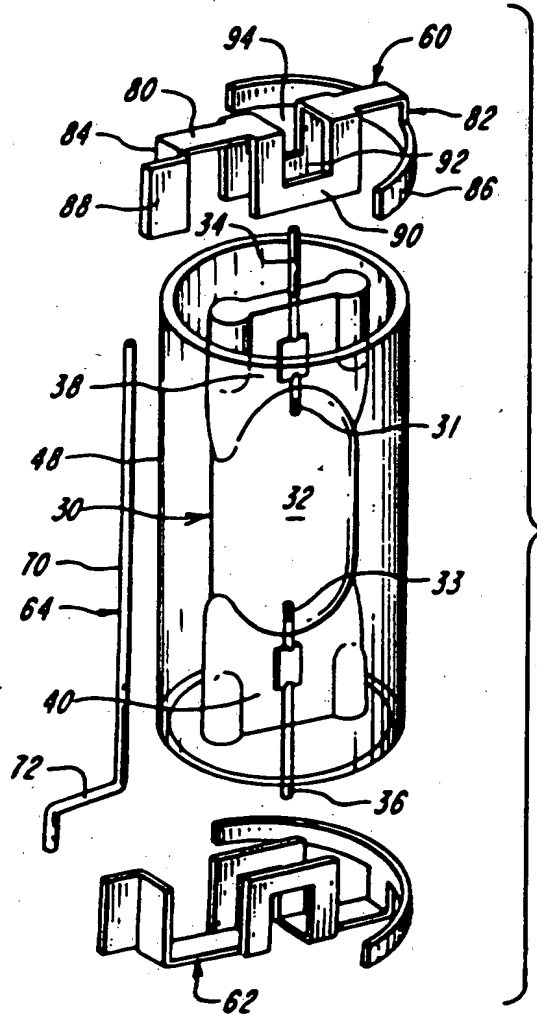


FIG. 3

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